

1 CLAIMS:

- 2 1. A phase shifter comprising:
- 3 a first power divider configured to receive a signal and provide
- 4 plural quadrature components of the signal;
- 5 plural mixers coupled with the first power divider and configured
- 6 to scale the quadrature components using a phase shift angle; and
- 7 a second power divider coupled with the mixers and configured
- 8 to combine the scaled quadrature components to shift the phase angle
- 9 of the input signal by the phase shift angle.
- 10
- 11 2. The phase shifter according to claim 1 wherein the first
- 12 power divider comprises a ninety degree power divider configured to
- 13 provide the signal into a sine component and a cosine component.
- 14
- 15 3. The phase shifter according to claim 1 further comprising
- 16 a storage device configured to store plural sine values and plural cosine
- 17 values and to output a sine value and a cosine value individually
- 18 corresponding to the phase shift angle.
- 19
- 20 4. The phase shifter according to claim 1 further comprising
- 21 a storage device configured to store a sine value and a cosine value
- 22 individually corresponding to the phase shift angle.
- 23
- 24

1           5.    The phase shifter according to claim 4 wherein the mixers  
2 are coupled with the storage device and individually configured to  
3 multiply one of the quadrature components by one of the sine value  
4 and the cosine value.

5  
6           6.    The phase shifter according to claim 1 wherein the second  
7 power divider comprises a zero degree power divider configured to add  
8 the scaled quadrature components.

9  
10          7.    A phase shifter comprising:  
11           a first input configured to receive a signal having a phase angle;  
12           a second input configured to receive a phase shift angle;  
13           a first power divider coupled with the first input and configured  
14 to provide the signal into a first component and a second component;  
15           a first mixer coupled with the first power divider and the second  
16 input and configured to scale the first component using the phase shift  
17 angle;  
18           a second mixer coupled with the first power divider and the  
19 second input and configured to scale the second component using the  
20 phase shift angle; and  
21           a second power divider coupled with the first mixer and the  
22 second mixer and configured to combine the first scaled component and  
23 the second scaled component to shift the phase angle of the input  
24 signal by the phase shift angle.

1           8.    The phase shifter according to claim 7 wherein the first  
2 power divider comprises a ninety degree power divider configured to  
3 provide the signal into quadrature components.

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5           9.    The phase shifter according to claim 7 wherein the first  
6 power divider is configured to provide the signal into a sine component  
7 and a cosine component.

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9           10.   The phase shifter according to claim 7 further comprising  
10 a storage device coupled with the second input and being configured to  
11 store plural sine values and plural cosine values and output a sine  
12 value and a cosine value individually corresponding to the phase shift  
13 angle.

14  
15           11.   The phase shifter according to claim 7 further comprising  
16 a storage device configured to store a sine value and a cosine value  
17 individually corresponding to the phase shift angle.

18  
19           12.   The phase shifter according to claim 11 wherein the mixers  
20 are coupled with the storage device and individually configured to  
21 multiply one of the first and second components by one of the sine  
22 value and the cosine value.

13. The phase shifter according to claim 7 wherein the second power divider comprises a zero degree power divider configured to add the first scaled component and the second scaled component.

14. An interrogator of a backscatter communication system comprising:

a transmitter configured to output a local continuous wave signal and a radio frequency continuous wave signal; and

a receiver configured to receive the local continuous wave signal and a modulated radio frequency continuous wave signal, the receiver including:

a phase shifter configured to adjust a phase angle of the local continuous wave signal by a phase shift angle, the phase shifter including a first power divider configured to provide a first component and a second component of the local continuous wave signal, plural mixers configured to scale the first component and the second component using the phase shift angle, and a second power divider configured to combine the scaled first component and the scaled second component to provide an adjusted continuous wave signal; and

a coupler configured to combine the adjusted continuous wave signal and the modulated radio frequency continuous wave signal.

1 ~~15~~<sup>2</sup>. The interrogator according to claim ~~14~~<sup>1</sup> wherein the first  
2 power divider is configured to provide the signal into quadrature  
3 components.

4  
5 ~~16~~<sup>3</sup>. The interrogator according to claim ~~14~~<sup>1</sup> wherein the first  
6 power divider comprises a ninety degree power divider configured to  
7 provide the signal into a sine component and a cosine component.

8  
9 ~~17~~<sup>4</sup>. The interrogator according to claim ~~14~~<sup>1</sup> further comprising a  
10 storage device configured to store plural sine values and plural cosine  
11 values and output a sine value and a cosine value individually  
12 corresponding to the phase shift angle.

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14 ~~18~~<sup>5</sup>. The interrogator according to claim ~~14~~<sup>1</sup> further comprising a  
15 storage device configured to store a sine value and a cosine value  
16 individually corresponding to the phase shift angle.

17  
18 ~~19~~<sup>6</sup>. The interrogator according to claim ~~18~~<sup>5</sup> wherein the mixers  
19 are coupled with the storage device and individually configured to  
20 multiply one of the first and second components by one of the sine  
21 value and the cosine value.

20. The interrogator according to claim 14 wherein the second power divider comprises a zero degree power divider configured to add the scaled first component and the scaled second component.

21. A phase shifter comprising:

a first input configured to receive a signal having a phase angle;

a second input configured to receive a phase shift angle;

a storage device configured to receive the phase shift angle, to store plural sine values and plural cosine values, and to output the sine value and cosine value which correspond to the phase shift angle;

a ninety degree power divider coupled with the first input and configured to provide the signal into a sine component and a cosine component;

a first mixer coupled with the ninety degree power divider and the storage device and configured to multiply the sine component of the signal by the sine value corresponding to the phase shift angle;

a second mixer coupled with the ninety degree power divider and the storage device and configured to multiply the cosine component of the signal by the cosine value corresponding to the phase shift angle; and

a zero degree power divider coupled with the first mixer and the second mixer and configured to add the sine component of the signal and the cosine component of the signal to shift the phase angle of the signal by the phase shift angle.

1 22. A method of shifting a phase angle of a signal comprising:  
2 providing a signal having a phase angle;  
3 providing a phase shift angle;  
4 providing the signal into a first component and a second  
5 component;

6 scaling the first component using the phase shift angle;  
7 scaling the second component using the phase shift angle;  
8 combining the first component and the second component after the  
9 scalings to shift the phase angle of the signal by the phase shift angle.

10  
11 23. The method according to claim 22 wherein the providing the  
12 signal into a first component and a second component comprises  
13 providing the signal into quadrature components.

14  
15 24. The method according to claim 22 wherein the providing the  
16 signal into a first component and a second component comprises  
17 providing the signal into a sine component and a cosine component.

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19 25. The method according to claim 22 further comprising:  
20 storing a plurality of sine values and cosine values; and  
21 outputting one sine value and one cosine value individually  
22 corresponding to the phase shift angle.

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1           26. The method according to claim 22 further comprising storing  
2 a sine value and a cosine value individually corresponding to the phase  
3 shift angle.

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5           27. The method according to claim 26 wherein the scalings  
6 individually comprise multiplying one of the first component and the  
7 second component by one of the sine value and the cosine value.

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9           28. The method according to claim 22 wherein the combining  
10 comprises adding the scaled first component and the scaled second  
11 component.

12  
13           29. A method of shifting the phase angle of a signal comprising:  
14 providing a signal having a phase angle;  
15 providing a phase shift angle;  
16 providing the signal into a sine component and a cosine  
17 component;

18           multiplying the sine component by a sine value corresponding to  
19 the phase shift angle;

20           multiplying the cosine component by a cosine value corresponding  
21 to the phase shift angle; and

22           adding the sine component and the cosine component after the  
23 multiplyings to shift the phase angle of the signal by the phase shift  
24 angle.



1           30. The method according to claim 29 further comprising storing  
2 a plurality of sine values and cosine values and outputting a sine value  
3 and a cosine value individually corresponding to the phase shift angle.

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5           31. The method according to claim 29 wherein the providing the  
6 signal into a sine component and a cosine component comprises  
7 providing using a ninety degree power divider.

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9           32. The method according to claim 29 wherein the multiplying  
10 individually comprise multiplying using a mixer.

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12           33. The method according to claim 29 wherein the combining  
13 comprises adding the scaled first component and the scaled second  
14 component.

15  
16           34. The method according to claim 29 wherein the adding  
17 comprises adding using a zero degree power divider.

1 ~~35~~<sup>9</sup> A method of operating a coherent interrogator of a  
2 backscatter communication system comprising:

3 outputting a radio frequency continuous wave signal;

4 providing a local continuous wave signal;

5 receiving a modulated continuous wave signal;

6 providing a phase shift angle;

7 adjusting the phase of the local continuous wave signal using the  
8 phase shift angle to provide an adjusted continuous wave signal, the  
9 adjusting including:

10 providing the local continuous wave signal into a first  
11 component and a second component;

12 scaling the first component using the phase shift angle;

13 scaling the second component using the phase shift angle;

14 and

15 combining the first component and the second component  
16 after the scalings to shift the phase angle of the local continuous wave  
17 signal by the phase shift angle; and

18 combining the adjusted continuous wave signal and the modulated  
19 continuous wave signal.

20  
21 ~~36~~<sup>10</sup> The method according to claim ~~35~~<sup>9</sup> wherein the providing the  
22 signal into a first component and a second component comprises  
23 providing the signal into quadrature components.  
24

1 ~~37~~<sup>11</sup> The method according to claim ~~35~~<sup>9</sup> wherein the providing the  
2 signal into a first component and a second component comprises  
3 providing the signal into a sine component and a cosine component.

4  
5 ~~38~~<sup>12</sup> The method according to claim ~~35~~<sup>9</sup> further comprising storing  
6 a plurality of sine values and cosine values and outputting a sine value  
7 and a cosine value individually corresponding to the phase shift angle.

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9 ~~39~~<sup>13</sup> The method according to claim ~~35~~<sup>9</sup> further comprising storing  
10 a sine value and a cosine value individually corresponding to the phase  
11 shift angle.

12  
13 ~~40~~<sup>14</sup> The method according to claim ~~39~~<sup>13</sup> wherein the scalings  
14 individually comprise multiplying one of the first component and the  
15 second component by one of the sine value and the cosine value.

16  
17 ~~41~~<sup>15</sup> The method according to claim ~~35~~<sup>9</sup> wherein the combining  
18 comprises adding the scaled first component and the scaled second  
19 component.

20 Add  
21 A2  
22  
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